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Description

AIR BAG INFLATOR GAS VENTING SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a division of U.S. application Serial Number 10/117,153 filed April 5, 2002.

BACKGROUND OF INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates generally to a passenger vehicle occupant restraint system having an air bag module and, more particularly, to an air bag module having direct venting.

[0004] 2. Background Art

[0005] Occupant restraint systems employing air bag modules are well known. During a collision of a predetermined magnitude, an air bag cushion is inflated by an inflator and is deployed in the vehicle for protection of the vehicle occupant. The air bag cushion is deployed at a high rate

of speed and force optimized to protect a wide range of occupants under various conditions. There are, however, times when deploying an air bag cushion is not desirable, such as when a vehicle occupant is so close to the air bag that normal deployment of the air bag may cause injury to the occupant. An occupant that is too close to the air bag is said to be out of position. Various air bag module designs have been developed to reduce the amount of pressure and force caused by an air bag deployment to an out of place vehicle occupant. For example, some systems use vents on the air bag cushion that open and release gases generated by the inflator as the bag is deploying. However, these systems only control the rate and amount of inflation of the air bag cushion in a predetermined manner, but do not do so in response to the position of the occupant.

[0006] Another system disclosed in U.S. Patent No. 6,206,408 uses vents on the air bag canister side wall that are initially open and slidingly close if no force is exerted on the deployment door. If force is exerted onto the deployment door, the vents remain open and the gas is vented therethrough, thereby thwarting deployment of the air bag cushion. However, this device is exceedingly compli-

cated to manufacture requiring sliding mechanisms.

[0007] It would be desirable to have an occupant restraint system employing an air bag cushion that does not fully deploy when an occupant is out of position that is of a simple design.

SUMMARY OF INVENTION

[0008] It is an object of this invention to provide an occupant restraint system having an air bag module that does not fully deploy an air bag cushion if the vehicle occupant is out of position and is of a simple design.

[0009] Accordingly, this invention features an air bag module having direct venting of the air bag inflator gas into the ambient air if external force is exerted on the deployment door. If no external force is exerted on the deployment door, then the air bag cushion deploys normally through the deployment door and into the passenger compartment. The air bag module comprises an air bag canister having at least one side wall, the a side wall having a gas channel port to communicate with the ambient air, an air bag cushion attached to the canister, an inflator attached to the air bag canister for providing gas, a deployment door attached to the canister, a structural gas channel configured to communicate with the gas channel port to

provide venting of gas provided by the inflator to the ambient air if external force is applied to the deployment door, and a venting system connecting the structural gas channel to the gas channel port and operative to prevent venting of gas through the gas channel port from the canister when the air bag cushion is in a substantially deployed condition.

[0010] The venting system may include a plug located outside the canister and a pulling system to connect the plug to the air bag cushion. The plug may be connected directly to the air bag cushion by a plug tether or indirectly by connecting the plug tether to an air bag-shaping tether. During normal deployment of the air bag cushion, the tether connected to the plug is made taut, thereby pulling the plug into the gas channel port and preventing any gas from venting therethrough.

Brief Description of Drawings

[0011] Figure 1 is a cross-sectional view of a first embodiment of the air bag module of the present invention in the undeployed condition;

[0012] Figure 2 is a cross-sectional view of the first embodiment of the air bag module of the present invention with the air bag deployed;

[0013] Figure 3 is a cross-sectional view of a second embodiment of the air bag module of the present invention in the undeployed condition;

[0014] Figure 4 is a cross-sectional view of the second embodiment of the air bag module of the present invention with the air bag deployed;

[0015] Figure 5 is a cross-sectional view of a second embodiment of the plug and the gas channel port of the present invention in a position to allow venting;

[0016] Figure 6 is a cross-sectional view of a second embodiment of the plug and the gas channel port of the present invention in a position to prevent venting;

[0017] Figure 7 is a view taken along line 7-7 in Figure 3;

[0018] Figure 8 is a cross-sectional view of a third embodiment of the air bag module of the present invention in the undeployed condition; and

[0019] Figure 9 is a cross-sectional view of the third embodiment of the air bag module of the present invention with the air bag deployed.

DETAILED DESCRIPTION

[0020] Referring now to Figures 1 and 2, a first embodiment of an air bag module 1 of the present invention is shown.

This embodiment and the embodiments subsequently discussed are described in United States Patent Application No. 10/117,153, which is incorporated by reference in its entirety.

[0021] In Figures 1 and 2, an air bag cushion 10 is shown in non-deployed and deployed positions, respectively. The air bag module 1 comprises an inflator 20 attached to a canister 40 preferably having a backing plate 42 and side walls 44. At least one side wall 44 has at least one gas channel port 46 thereon to vent gas to the ambient air if necessary. The canister can be made circular thereby having only a single side wall 44 or polygonal having multiple side walls. Additionally, there may be more than one gas channel port 46.

[0022] A structural gas channel 60, made out of at least a semi-rigid material, communicates with the gas channel port 46 to vent into the ambient air. The structural gas channel 60 must be rigid enough not to deform from the heat and pressure generated by the inflator 20 or from the packaging pressure of the air bag cushion 10. The structural gas channel 60 is pivotally connected to the canister side walls 44 by a non-porous fabric gas channel 65, which is flexible but does not let a substantial amount of gas perme-

ate. The non-porous fabric gas channel 65 is pivotally attached to a canister side wall 44 by a known method. The structural gas channel 60 may pivotally connect to the side wall directly or may indirectly connect to the side wall 44 through the non-porous fabric gas channel 65.

[0023] An air bag cushion 10 is attached to the canister side walls 44 using known methods such as a rivet 55. At least one bag-shaping tether 15 is connected at a first location 15a to the side wall 44 and at a second location 15b to the air bag cushion 10. Bag-shaping tether 15 controls the deployed shape of the air bag cushion 10, as is well known in the restraints art. Tether 15 is also connected to the structural gas channel 60 at a third location 15c. A deployment door 30 is attached to the canister side wall 44 using known attachment means such as a rivet 50.

[0024] During normal deployment of the air bag cushion 10 as shown in Figure 2, the inflator 20 begins inflating the air bag cushion using inflator nozzles 25 by known methods. The air bag cushion 10 expands and begins exerting a force on the deployment door 30. A majority of the gas generated by the inflator 20 goes into expanding the air bag cushion 10 while a smaller amount may be vented through the gas channel port 46. When enough gas accu-

mulates in the air bag cushion 10, the air bag cushion deploys in a normal manner by bursting through the deployment door 30 and fully inflating within the vehicle to protect the occupant (not shown). As the cushion 10 expands out of the canister 40, it pulls bag-shaping tether 15 taut, thereby pulling the structural gas channel 46 and the non-porous fabric gas channel 65 so that they pivot upward to the position shown in Figure 2. In this position, non-porous fabric gas channel 65 blocks off the gas channel port 46, thus allowing the air bag cushion 10 to fully inflate.

[0025] If, however, a force is exerted on the deployment door 30 by, for example, an out-of-position occupant (not shown), the gas generated by the inflator 20 is not able to expand the air bag cushion 10 to the point where deployment of the air bag cushion pulls bag-shaping tether 15, structural gas channel 60, and non-porous fabric gas channel 65 to the position shown in Figure 2. Instead, the gas channels 60, 65 remain substantially in the position shown in Figure 1 so that most of the inflation gas exits through the structural gas channel 60 and the non-porous fabric gas channel 65, thus preventing full deployment of the air bag cushion. This prevents the undesirable

situation of the air bag cushion 10 deploying directly into an out-of-position occupant with sufficient force to cause injury.

[0026] If a particular air bag design does not include a bag-shaping tether, structural gas channel 60 may be attached to air bag cushion 10 by a tether provided specifically for that purpose.

[0027] In a second embodiment of the invention illustrated in Figures 3, 4 and 7, a plug 70 is used to prevent venting of inflator gases to the ambient air during a normal air bag deployment. Plug 70 is shown to be spherical, but may be of any appropriate shape, such as conical, hemispherical, or tapered. The structural gas channel 60 is not pivotally attached but is instead connected to the canister 40. A plug centering guide 80 is preferably attached to the canister side wall 44 in alignment with the gas channel port 46. Alternatively, the plug centering guide 80 may be part of the gas channel port 46. The plug centering guide is preferably made of injection molded plastic, but may be made of any appropriate material. As best seen in Figure 7, plug centering guide 80 comprises a plurality of radial arms 82 connecting to a peripheral support structure 84 having a guide hole 89. Venting is provided through

openings 86 between the radial arms 82 and the support structure 84.

[0028] A plug tether 72 is connected to the bag-shaping tether 15, extends through an opening 61 in the structural gas channel 60, through the guide hole 89, and is attached to the plug 70. During normal deployment of the air bag cushion 10, the inflator 20 inflates the air bag cushion which bursts through the deployment door 30 and pulls on the tether 15. As the tether 15 is pulled, it pulls on the plug tether 72 drawing the plug 70 into the plug centering guide 80, thereby preventing venting to the ambient air. The plug may either nest in the gas channel port 46 or on the plug centering guide 80 to block the venting of gas. If the plug nests on the plug centering guide, the plug centering guide is preferably conically shaped to ensure a better seal.

[0029] An alternative embodiment of the structural gas channel 60, the plug 70, and the plug centering guide 80 is shown in Figures 5 and 6. The plug 70 and the plug centering guide 80 are located inside the structural gas channel 60. Otherwise, the plug 70 functions exactly the same. Plug 70 must be small enough in diameter that it does not impede the proper flow of gas outward through structural

gas channel 60 unless the plug is pulled firmly into plug centering guide 80.

[0030] If force is applied to the deployment door 30 by an out-of-position occupant, the gas generated by the inflator 20 is not able to expand air bag cushion 10 to the point where plug tether 72 pulls plug 70 into centering guide 80 so as to block the flow of gas. As a result, the gas is free to flow out through the structural gas channel 60, the gas channel port 46, and the plug centering guide 80.

[0031] If a particular air bag design does not include a bag-shaping tether, plug tether 72 can connect the plug 70 directly to the air bag cushion 10.

[0032] A third embodiment of the present invention is shown in Figures 8 and 9. The structural gas channel 60 communicates with the gas channel port 46 in the canister 40 through a non-porous fabric gas channel 65. In this embodiment, the structural gas channel 60 is fixed to the backing plate 42 to prevent it from moving. A cinch strap 90 connected to the tether 15 is wrapped around the non-porous fabric gas channel 65. When the air bag cushion 10 is properly deployed, the tether 15 pulls on the cinch strap 90, thereby closing the non-porous fabric gas channel 65 and preventing gas from venting through gas

channel port 46.

[0033] However, when an external force is applied to the deployment door 30, the air bag cushion 10 is prevented from deploying fully, and therefore the bag-shaping tether 15 does not pull on cinch strap 90 sufficiently to close off the fabric gas channel 65. Structural gas channel 60 and non-porous fabric gas channel 65 remain open and gas is vented therethrough to the ambient air.

[0034] Alternatively, a cinch strap 90 can connect the non-porous fabric gas channel 65 directly to the air bag cushion 10 such that the deploying air bag cushion cinches the non-porous fabric gas channel without the need for a bag-shaping tether.

[0035] While the best mode for carrying out the invention has been described in detail, those familiar with the art to which this invention relates will recognize various alternative designs and embodiments for practicing the invention as defined by the following claims.